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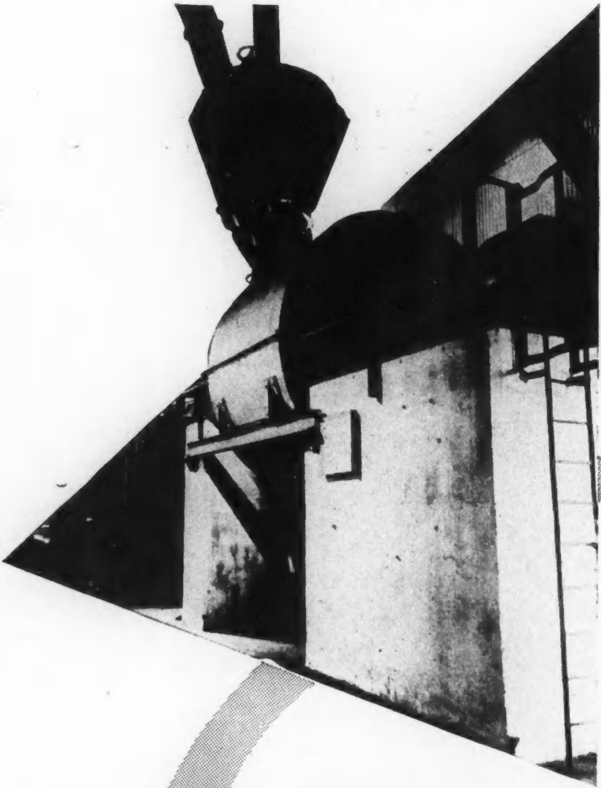

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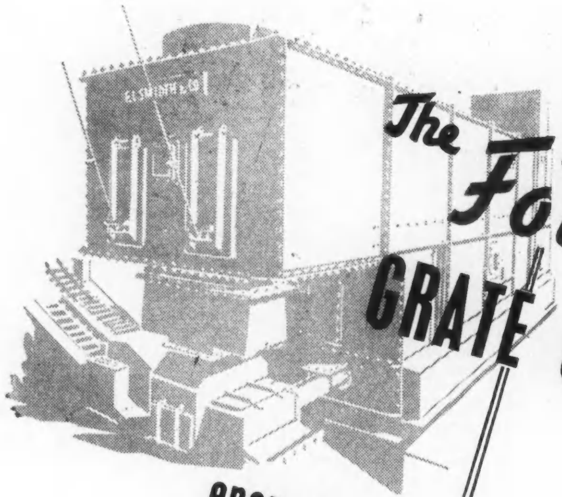

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Hydrophobic Cement.

By R. W. NURSE, M.Sc., F.Inst.P.

INTEREST has been aroused by the reported development in the U.S.S.R. of a modified type of Portland cement for use especially in the large hydro-electric, irrigation, and water-transport schemes at present under construction in Russia. The cement is described as hydrophobic or water-repellent and is obtained by grinding ordinary Portland cement clinker with a film-forming admixture which may contain some or all of the three substances " soap oil," oleic acid, and betaine hydrochloride. The merits claimed for the treated cement are:

(1) The addition acts as a grinding aid in manufacture, thus producing a finer cement for the same power consumption or a saving in power for the same fineness of cement.

(2) The water-repellent film formed around each grain of cement markedly reduces the rate of deterioration of the cement during storage, or during transport under unfavourable conditions as in barges or open trucks. The film is broken down when aggregate is added and the materials are mixed together.

(3) During mixing, the additive is said to plasticise the cement without excessive air-entrainment, thus permitting a reduction of the water content. Consequently, either concrete of higher strength is obtained, or a lower cement content can be used for the same strength.

(4) The hardened concrete is said to have reduced permeability and water absorption.

The effects described in (1), (3), and (4) are well known in concrete practice; the uses of grinding aids in manufacture, of plasticising and air-entraining agents in making concrete, and of additions designed to make the hardened concrete

waterproof have been the subject of research, development, and application throughout the world. The most novel feature of hydrophobic cement is the claim that it resists weathering and does not deteriorate during storage.

Tests at Building Research Station.

A short investigation of this claim has been made at the Building Research Station. Various proprietary materials sold as additives to cement were tested as well as fatty acids, betaine hydrochloride, and waxes of various kinds. Some trials were also made with a solution of pentachlorophenol in chlor-X-cryselic, the use of which is patented.*

For these preliminary tests Portland cement clinker was crushed to pass a ¼-in. sieve and weighed into ½-kg. samples with 4 per cent. by weight of rock gypsum. The agent was sprinkled on the clinker and the sample ground in a small closed ball-mill for six hours, the specific surface being then determined by the British Standard air-permeability method. It was considered that if the resultant cement floated on water it could be classed as hydrophobic in some degree, and this simple test was used in rapidly classifying the effect of the agents tested. A series of typical test results is given in *Table* I.

TABLE I. EFFECT OF OLEIC ACID ON SPECIFIC SURFACE AND WATER-REPELLENCY.

Percentage of oleic acid added	Specific surface (sq. cm. per gm.)	Float test
none	4780	Sank.
0·10	4750	Floated 7 days.
0·25	6150	Floated indefinitely.
0·35	6450	,, ,,
0·50	6250	,, ,,
0·75	5610	,, ,,
1·00	5480	,, ,,

It was found that oleic, lauric, and stearic acids and pentachlorophenol were effective both as grinding aids and as hydrophobic agents. None of the other materials tested was effective in either capacity. It was decided to carry out tests on a larger scale using 0·35 per cent. of oleic acid and 0·75 per cent. of pentachlorophenol. A sample of treated cement of the latter composition was provided by the patentees. Certain proprietary types of "waterproof" cement contain calcium stearate, and one of these was included in the trials.

Standard Tests.

The results of tests according to British Standard No. 12:1947 are given in *Table* II, and the strengths of 1 : 2 : 4 concretes with a water-cement ratio of 0·6, stored in water and in air, is given in *Table* III. A normal Portland cement is included for comparison; this is the same control cement used in the exposure tests described later. It should be noted that since the different cements came from varying sources the basic cement clinker is not the same, and consequently

* British Patent No. 22714; September 28, 1951.

the differences between the cements in *Tables* II and III cannot be definitely ascribed to the presence of the additives. It seems probable, however, that the low strength of the cement treated with oleic acid at one day can be ascribed to the highly water-repellent film formed on the cement ; this cement was very fine and consequently fast setting. Otherwise *Tables* II and III show that all the cements to have normal setting and hardening properties.

ACCELERATED TESTS FOR AERATION.—About 15 lb. of cement were spread uniformly in a layer ½ in. thick and exposed to air at 64 deg. F. and 90 per cent. relative humidity. The cement was stirred every four days and any lumps broken up. After aeration the cement was exposed for a few hours at 42 per cent.

TABLE II.

Additive	Cement Properties						
	Setting time		Le Chatelier expansion (mm.)	Compressive strength of 1 : 3 mortar cubes (lb. per sq. in.)			
	Initial	Final		1 day	3 days	7 days	28 days
	hrs. mins.	hrs. mins.					
None (control) ..	2 43	3 33	1·0	1090	3270	5140	7600
Oleic acid ..	1 00	1 10	1·0	316	2820	5260	7090
Pentachlorophenol	2 39	3 19	1·0	1080	3200	4060	5950
Calcium stearate	2 55	3 27	1·0	1350	3660	3970	5030

TABLE III.

Additive	Compressive strength in lb. per sq. in. of 4-in. cubes, 1 : 2 : 4 concrete, water-cement ratio 0·60								
	Stored in water					Stored in air			
	1 day	3 days	7 days	1 mo.	3 mos.	3 days	7 days	1 mo.	3 mos.
None (control)	845	2410	3790	5440	6870	2340	3550	5090	6190
Oleic acid	Not enough material for test								
Pentachlorophenol ..	380	1100	1750	2480	3240	1030	1440	2170	2620
Calcium stearate ..	670	1870	2580	3660	4790	1840	2520	3770	4390

relative humidity to bring the free moisture to a standard value before testing. The results of standard tests after aeration are given in *Table* IV.

AIR ENTRAINMENT.—The appearance during gauging of the cement treated with oleic acid gave rise to the suspicion that excessive air-entrainment was taking place. The strengths of mortars were, however, normal, in disagreement with the earlier supposition. In order to clarify the point, a special test for air-entrainment was carried out on hand-mixed 1 : 3 mortar with a water-cement ratio of 0·6. The mixture comprised 100 gm. of cement, 100 gm. of river sand between 52 and 100 mesh, and 200 gm. of river sand between 25 and 52 mesh. Dry mixing was carried out for one minute, followed by three minutes' wet mixing with a spatula on a glass plate. After allowing the mixture to stand for one minute, it was mixed for a further three minutes. The air content was measured in the A.S.T.M. meter and also calculated from the density. *Table* V gives the results.

TABLE IV. EFFECT OF EXPOSURE TO AIR AT 90 PER CENT. RELATIVE HUMIDITY.

Additive	CO_2 content (per cent.)				Loss on ignition (per cent.)				Compressive strength of 1 : 3 mortar cubes after 7 days' curing				
	As received	14 days' exposure	28 days' exposure	3 mos. exposure	As received	14 days' exposure	28 days' exposure	3 mos. exposure	As received	14 days' exposure	28 days' exposure	3 mos. exposure	6 mos. exposure
None (control) ..	0·57	3·43	6·35	—	1·32	5·61	9·35	—	5140	2430	1100	—	—
Oleic acid.. ..	0·24	0·39	0·46	0·53	1·08	1·57	1·52	1·83	5260	5100	5270	5390	5800
Pentachlorophenol	0·80	1·60	2·35	10·04	—	4·22	5·70	17·70	4060	5100	4210	550	260
Calcium stearate..	0·82	2·63	4·10	4·71	—	6·65	9·00	—	3970	4360	2320	470	130

TABLE V. AIR CONTENTS OF 1 : 3 MORTARS (WATER-CEMENT RATIO 0·6).

Cement	Air content	
	By meter	From density
Normal Portland	8·5 9·1 9·2	8·0 8·0 8·5
Treated with oleic acid	8·0 10·3 9·7	11·5 10·0 11·5
Treated with pentachlorophenol	10·9 11·1	10·0 10·5
Commercial water-repellent..	10·6 10·0	10·0 9·5
Normal Portland + 0·1 per cent. Vinsol resin	10·9 10·9	10·5 10·0

Discussion and Conclusions.

The data available are limited and suffer from the disadvantage that a single cement clinker could not be used throughout the tests. However, the results show clearly that cement can be effectively protected against deterioration caused by exposure to moist air. It is apparently essential to the process that the agent used be added in such a way that an oriented film is formed on the grains of cement. This is shown by the difference in behaviour when calcium oleate is formed on the surface of the cement by the addition of oleic acid and when calcium stearate is added.

Betaine hydrochloride is not a hydrophobic agent and it is not clear why it is mentioned in the Russian reports. " Soap oil " is believed to be a waste product not available in the United Kingdom. The cost of the additive would be offset to some extent by a saving in grinding costs.

Oleic acid, which is the most effective hydrophobic agent, is about as effective in entraining air (in the concentration used) as an addition of 0·1 per cent. of Vinsol resin. This would account for the reported increase in the workability of concrete and the other properties claimed for hydrophobic cement.

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The Cement Industry Abroad.

Yugoslavia.

THE production of cement in Yugoslavia in the year 1952 was 1,313,000 tons, an increase of 13 per cent. over the previous year.

Siam.

IN the year 1952 the Thai Cement Company produced 240,000 tons of cement. It is estimated that the Company's production will be 350,000 tons in the present year and 400,000 tons in the year 1954. The selling price is about 10 per cent. cheaper than that of cement imported from Japan.

Belgium.

THE total production of all types of cement in Belgium during the year 1952 was 4,210,000 tons. Compared with the average production during the years 1936 to 1938, this is an increase of about 40 per cent.

Turkey.

THE new cement factory at Izmir is nearing completion. When it is in operation and the present programme of enlargements has been carried out at existing plants, production is expected to rise from 400,000 tons to 900,000 tons per annum. The Industrial Development Bank is assisting this development by means of the following loans: T.£5,600,000 to Cimentas, Izmir; T.£4,110,000 to the Arslan and Eskisehir works; T.£2,953,000 to Turk Cimento ve Kireci A.S.; T.£784,000 to Anadolu Cimentolari T.A.S.

The Cement Industry in Greece.

THE cement industry in Greece, which has doubled its production in the past three years, now produces all the cement needed in Greece and is developing an export trade. Of the total production of 596,000 tons in the year 1952, 101,000 tons were exported. It is expected that new equipment installed this year will increase the capacity of the industry to 820,000 tons, of which 250,000 tons would be available for export. In 1939 the production of cement in Greece was 334,000 tons.

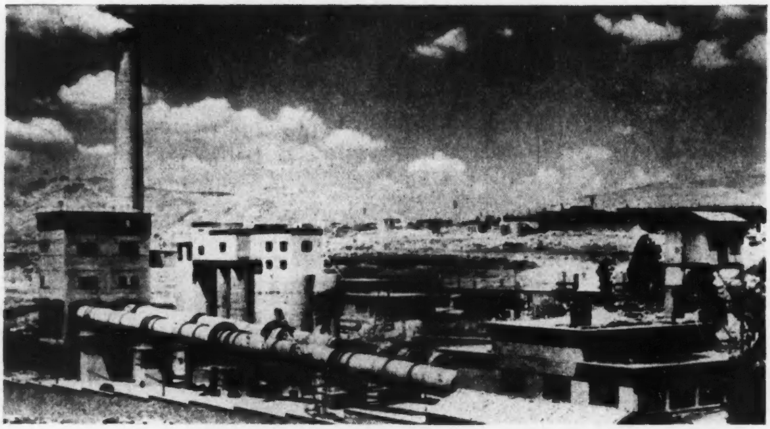


Fig. 1.—New Kilns at Heracles Works.

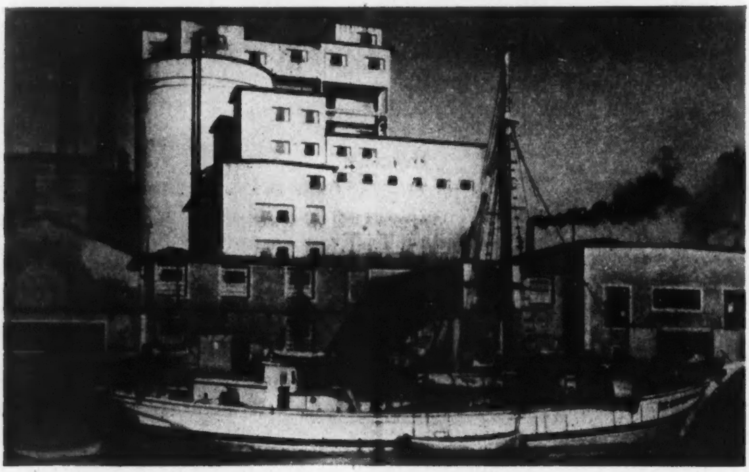


Fig. 2.—The Titan Works.

Under the "Marshall Plan," loans of £2,250,000 were made in 1949 and 1950 to the General Cement Co. (which owns the Heracles works at Piraeus and the Olympus works at Volos) and to the Titan Cement Co. whose works at Eleusis is the largest in Greece. These works were extended to accommodate new equipment bought in Europe and the U.S.A. with the aid of the American loans. These three works produced 486,000 tons of cement in 1952, the rest being made by the Chalyps Cement Co. at Eleusis, the Atlas Cement Co. at Athens, and the Chalkis Cement Co. at Chalkis.

The two new kilns (made in the U.S.A.), each with a capacity of 100,000 tons a year, at the Heracles works are claimed t be the longest dry-process kilns in the world (*Fig.* 1). They are 400 ft. long and 11 ft. diameter ; a kiln of the same type is being installed at the Olympus works. Two new grinding mills at the Heracles works have a capacity of 40 tons per hour each ; they are driven by 1,000-h.p. motors. Crushed material is stored in eight bins each of 150-tons capacity and is moved to the kilns by conveyor-belts and feeders with automatic scales.

The two new kilns (supplied from Denmark) at the works of the Titan Co. at Eleusis are each 350 ft. long with diameters of about 11 ft. All movement of raw material and cement is carried out by compressed air. The capacity of the works is now 1,000 tons per day. A view of this works is given in *Fig.* 2.

Cement Production in Norway.

THE production of cement in Norway in the year 1952 amounted to 730,000 tons. It is estimated that the requirement in the year 1953 will be about 876,000 tons.

New Works in Belgian Congo.

A NEW cement works, with a capacity of 12,000 tons a year, started production at Jadotville in April last.

Book Review.

The Measurement of Particle Size in Very Fine Powders. By H. E. Rose. (*London: Constable & Co., Ltd.* 1953. *Price* 9*s*.)

This book is based upon four lectures delivered by the author at King's College, London, during the year 1951. Most of the methods described apply mainly, but not exclusively, to particles with diameters between 0·001 mm. and 0·06 mm. This range of sizes was chosen because particles larger than 0·06 mm. may be dealt with satisfactorily by sieving, and for sizes below 0·001 mm. many of the physical processes normally employed are not valid.

A sufficient mathematical treatment of the subject is given to form a basis for the application of the methods described. These include the measurement of particle sizes by elutriation, sedimentation, photo-extinction, and the use of the microscope, and measurement of the specific surface by permeability, photo-extinction, nitrogen adsorption, tinting strength, and bulk density. Methods of determining the mean particle size by diffraction rings are also described. No details are given of the use of the electron-microscope and the ultra-centrifuge which are considered to be methods too specialized for general discussion.

The writer gives examples of different specific surfaces obtained with different methods of measuring the area of the particles and mentions a cement for which the specific surface, in square centimetres per gramme, was 2,780 when measured by the photo-extinction method and 10,000 when measured by the nitrogen-adsorption test. This, it is stated, shows the desirability of measuring the specific surface by a process similar to that for the control of which the data are required ; in this case a chemical reaction.

The Lepol "Double-pass" Kiln.

By DIPL. ING. BERND HELMING.

SOON after the war, when the Polysius organisation was established in Western Germany, it was decided to work on the further development and improvement of the Lepol kiln. At that time 120 Lepol kilns were in operation producing more than 10 million tons of clinker a year. Experience had shown that various details of the design could be improved, but it was also thought that the process itself might be capable of development.

It had been found with some of the very early Lepol kilns, for example, that granules made of some raw materials did not satisfactorily survive direct exposure to hot kiln-gases at temperatures of about 1000 deg. C. Very rapid drying of the skin sealed a kernel of moist material and led to the generation of steam and

Fig. 1.—Standard "Double-pass" Kiln with a capacity of 300 Tons a Day.

subsequent bursting and disintegration of the granules. This fragmentation of the top layer of granules blocked the interstices in the bed below and impeded the passage of the kiln gases. This difficulty had been overcome by the provision of an extra chamber at the beginning of the grate where dilution of the kiln gases by external air reduced the temperature to about 300 deg. C. and ensured slower drying of the granules throughout the layer. The cold air so introduced left the kiln at about 100 deg. C. and actually absorbed heat. Since about 35 cu. ft. of air are required per pound of clinker, this dilution of the gases cost the equivalent of about 80,000 calories per ton of clinker.

It was thought that the elimination of external air would result in a reduction of fuel consumption, and improvement in this direction was sought. Dr. Otto Lellep, the inventor of the Lepol kiln, after trials at the experimental station of the concern at Neubeckum, provided a solution to the problem by a " double-

pass" arrangement consisting of a grate with two compartments which are traversed by the kiln gases consecutively before being released to the atmosphere. The first compartment acts as a dryer and the second as a preheater and calciner. A fan draws the kiln exit-gases through the layer of granules in the preheating and calcining chamber, and delivers them at a reduced temperature to the drying

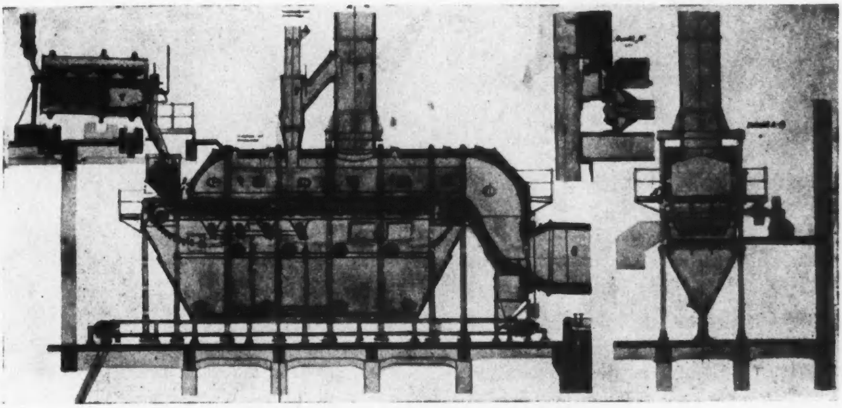


Fig. 2.—The Standard Lepol Grate.

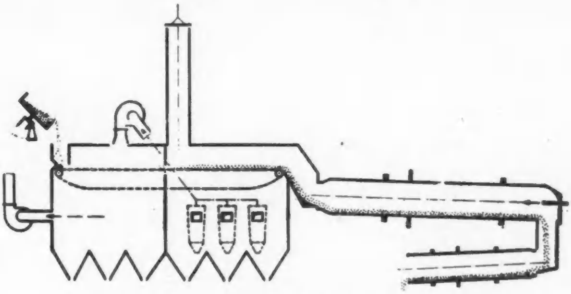


Fig. 3.—Diagram of "Double-pass" Grate.

section. A second fan draws these gases again through the layer of granules in the drying section and delivers them to the atmosphere. The trials proved that (1) Since the kiln exit-gases are not diluted by external air, the exit temperature could be as low as 80 deg. C. with a corresponding reduction of fuel consumption; (2) The "double-passing" of gases through the layer of granules and the grate results in a great reduction of dust losses, due to the filtering action of the layer of damp granules which is continuously renewed. *Figs.* 1 to 4 show double-pass kilns and details of the grate.

As a result of these tests, the Lepol kilns at that time (1948) on order were converted to the double-pass system, and orders were accepted for a number of

Fig. 4.—" Double-pass " Kiln with a capacity of 500 Tons a Day during erection.

these kilns with capacities up to 600 tons a day and with guaranteed fuel consumptions of 900,000 calories per ton of clinker. Six of these kilns are now in operation. They all exceed the guaranteed output by at least 10 per cent. and in one case 700 tons per day are obtained from a kiln with a guaranteed capacity of 500 tons a day. In the case of two kilns of 500 tons capacity, one kiln with a grate-type cooler consumes 870,000 calories while the other with a rotary cooler consumes 811,000 calories per ton only. These fuel consumptions are capable of further reduction in special cases. For example, a 250-tons kiln, the raw material for which consists in part of blastfurnace slag, has a fuel consumption equivalent to 750,000 calories per ton or, say, 10·7 per cent. standard coal by weight of clinker. Another double-pass kiln of 400 tons capacity is installed at a wet-process works where the slurry is dried by filtration and subsequently nodulised in a granulator, with provision for some pre-drying. A similar type of kiln has been installed for sintering crushed and graded magnesite rock. In the case of all these kilns it has proved possible—without any additional dust-collecting plant—to guarantee a dust loss of less than 1 per cent.

Chalk Crushing and Screening Plant.

A NEW crushing and screening plant designed and manufactured by the Fraser and Chalmers Engineering Works of the General Electric Co., Ltd., is in operation at the chalk quarries of the Chinnor Cement & Lime Co., Ltd. The plant is capable of handling, per hour, 70 tons of dry material containing pieces of the chalk as large as 36 in. by 24 in. by 24 in., and larger boulders have been handled.

The chalk is excavated by a 1 cu. yd. shovel and loaded into 5-tons dumpers, which carry it from the face to the crushing plant. The diagrammatic sections through the plant (*Figs.* 1 and 2) show how the chalk is tipped into a steel receiving hopper, 12 ft. long by 5 ft. wide by 7 ft. deep. From there it is fed into the crusher by a moving-bar grizzly feeder which is particularly suitable for handling sticky material containing large pieces. This feeder, 4 ft. wide by

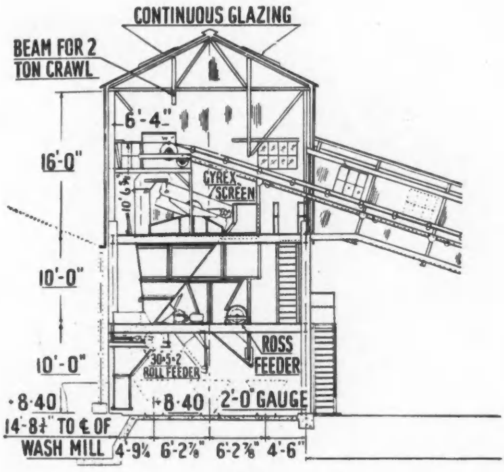


Fig. 1.

15 ft. long, removes the fines before they reach the crusher, allowing them to fall on to a belt conveyor. The feeder is driven by a 7½-h.p. slip-ring motor having a variable speed of 480 to 725 r.p.m. The power is transmitted through a vee rope-drive, spur gears, and eccentric shafts.

The chalk is crushed in a Fraser and Chalmers Pennsylvania single-roll crusher fitted with a manganese-steel toothed roll 2 ft. 6 in. diameter by 4 ft. 2 in. long (*Fig.* 3). This can be adjusted to crush the chalk to sizes as large as 9 in. or as small as 5 in. The roll has a speed of 35 r.p.m. and the crusher is driven by a 65-h.p. slip-ring motor having a speed of 725 r.p.m., the drive being transmitted by vee ropes to the counter-shaft of the crusher which is geared to the main roll. This type of crusher is suitable for reducing somewhat sticky material, which might pack in a jaw crusher. The breaker-plate is of cast steel with renewable

wearing plates of manganese steel and a bronze hinge shaft bush. The housings of the bearings for the roll shaft and the countershaft are also of cast steel with renewable bronze bushes. Lubrication is by means of a mechanical grease lubricator driven from the roll shaft.

The crushed chalk, together with the undersize material, then passes along an inclined belt conveyor, 2 ft. 6 in. wide by 156 ft. long, to the screening section. The conveyor is fitted with three-pulley type troughing idlers, with tapered-roller bearings and mounted on steel boards, those at the feed end being of the heavy rubber-cushioned type and spaced at not more than 2 ft. centres under the single-roll crusher. The return idlers also have tapered-roller bearings, while the head, tail, and snub pulleys are supported on roller bearings. A weighted belt cleaner and a hold-back gear of the pawl-and-ratchet type are fitted. A 10-h.p. high-torque squirrel-cage motor having a speed of 720 r.p.m. drives the conveyor through a worm reduction gear coupled to the head pulley shaft.

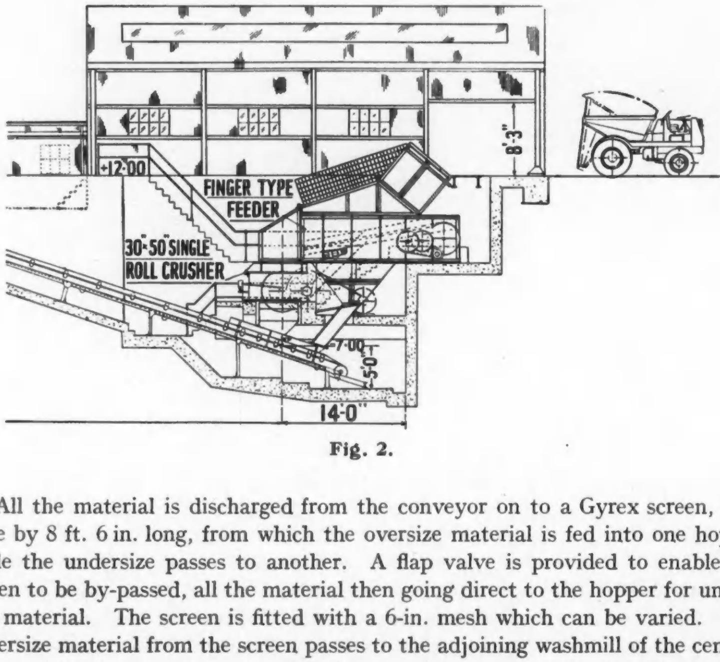


Fig. 2.

All the material is discharged from the conveyor on to a Gyrex screen, 5 ft. wide by 8 ft. 6 in. long, from which the oversize material is fed into one hopper while the undersize passes to another. A flap valve is provided to enable the screen to be by-passed, all the material then going direct to the hopper for undersize material. The screen is fitted with a 6-in. mesh which can be varied. The undersize material from the screen passes to the adjoining washmill of the cement plant, while the oversize material is discharged by means of a chain feeder into 1 cu. yd. Decauville wagons and is transported to the lime kilns. The chain feeder has a width of 2 ft. 6 in. and is fitted with a variable-speed reducing gear, driven by a 2 h.p., 720 r.p.m., motor. Frequently all the chalk is diverted to the cement plant, in which case the screening operation is omitted as described previously.

The screen is a heavy type, being vibrated by an eccentric shaft of large diameter and of high-grade steel, supported at its ends in heavy, self-aligning, double-roller bearings bolted to the base. Heavy roller bearings are also fitted in a tubular casting rigidly fastened to the sides of the vibrating frame so that the latter is given a circular motion of a stroke equal to twice the eccentricity of the shaft. Counterbalanced weights are provided with a vernier adjustment to prevent the vibration of the supporting structure. The screen is driven through a vee rope drive from a 7½-h.p. high-torque squirrel-cage motor having a speed of 720 r.p.m.

The discharge to the washmill is regulated by a roll feeder, 2 ft. 6 in. diameter by 5 ft. 2 in. wide, driven by a 2½ h.p. slip-ring motor having a variable speed of 480 to 725 r.p.m. An auxiliary chute is provided so that all the material can, if required, be emptied into Decauville wagons through a radial gate of 3 ft. radius by 3 ft. 6 in. wide.

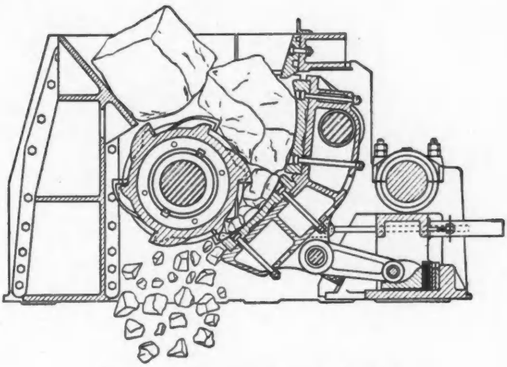


Fig. 3.—The Single-roll Crusher.

Two buildings were erected for the plant ; one for the receiving hopper, feeder and crusher, and the second for the screen with its hoppers and feeders. Both buildings are of structural steel with galvanised steel sheeting for the roofs and sides. An enclosed gallery covers the conveyor between the two buildings.

A 5-tons double-girder travelling crane, operated by hand, is used in the crusher house for servicing the crusher, feeder and other plant. This crane has a span of 24 ft. and travels on rails 25 ft. above the floor level. The hoisting motion of the crane, by worm gears fitted with an automatic self-sustaining arrangement, lifts the load on two parts of the chain and a return block. Two hand-operated chain wheels are provided to give two speeds to the lifting hook and similar chains are fitted for operation from the floor. Traverse and longitudinal motions are fitted with roller bearings and the hook is mounted on ball bearings. A travelling-block worm-gear, capable of lifting two tons, built into a 4-wheel trolley with gear for travelling on the lower flange of a steel joist, is used in the screen house. This also is operated by chains from the floor.

The Associated Portland Cement Manufacturers, Ltd.

AT the annual meeting of the stockholders of the Associated Portland Cement Manufacturers, Ltd. (the largest cement-making concern in the world), held in London last month, Mr. G. F. Earle, C.B.E., the Chairman, stated that the group delivered 7,400,000 tons of cement in the year 1952, an increase of more than 700,000 tons compared with the previous year. The production per man was greater than ever before, and was close to the rate achieved in the U.S.A. The group had agreed to purchase the cement produced at a new sulphuric-acid works in Cumberland ; it was anticipated that this would amount to 75,000 tons in the year 1955.

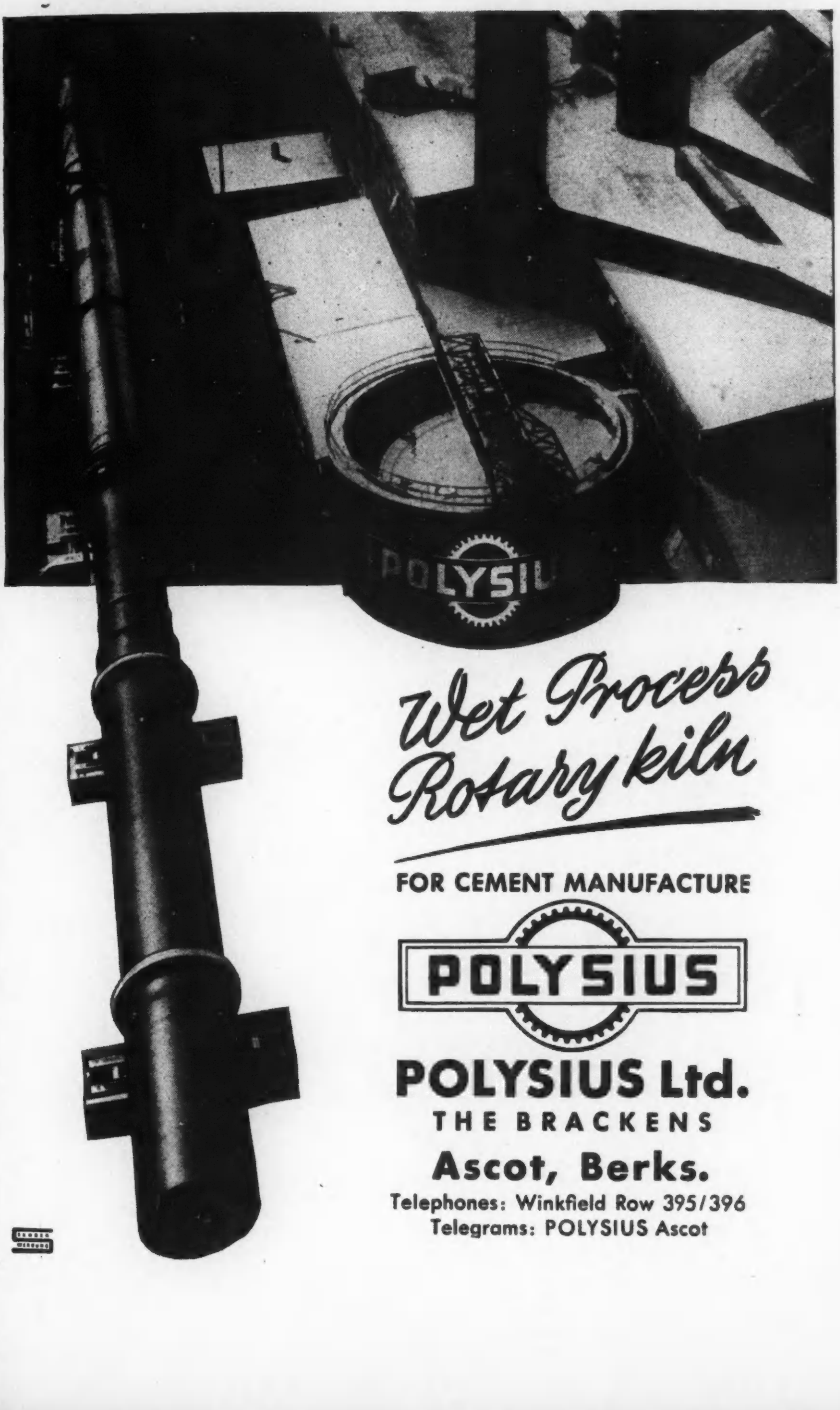
In referring to the overseas works of the group, the Chairman said that a new kiln was now in operation at the works in Australia. In Mexico the capacity of the larger works was being increased by 50 per cent. In British Columbia a new kiln and other plant were in operation, and they were considering the further expansion of their production in Canada. In New Zealand an additional kiln had been installed, and a ship to transport the major part of the output unpacked was being built in Scotland and should be in commission next year. In Malaya a new works was nearing completion and should be in production within a few weeks. In South Africa it was proposed to increase the output of the Lichtenburg works by the installation of an additional kiln. Investigations were also being made into the possibilities of building a works in Southern Rhodesia. The prospects of building a works in Kenya were now promising. This would be built by the East African Portland Cement Company in which the Associated group and the Tunnel Portland Cement Co., Ltd., had considerable interests.

A Patented Method of Improving the Plasticity of Cement

In order to improve the plasticity of hydraulic binding-agents such as cement, lime, or plaster of paris, an organic substance is added which forms a soluble alkaline-earth metal complex salt. The substances are (*a*) amino acids having two carboxyl groups of the formula

$$R.N(CH_2COOH)_2,$$

R being hydrogen or an organic residue, for example nitrilo triacetic acid, ethylene diamine tetracetic acid, imino-diacetic acid, methylimino-diacetic acid, anthranil acid, diacetic acid, uramil 7·7-diacetic acid or their alkali metal salts : (*b*) pyrocatechin disulphonic acid or its alkali metal salts : or (*c*) sodium citrate. Setting-regulators, such as alkaline earth or aluminium chlorides, aluminates, alkali hydroxides or carbonates, or waterglass, may be included. The substances may be introduced during manufacture of the binding agent or may be added with any of the ingredients during mixing.—British patent No. 650,745. K. Winkler & F. Schenker. December 23, 1947. [Publication of patent specifications has been delayed due to the war.]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